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## RECEPTACLE FOR CONNECTING TO FLEXIBLE CIRCUIT BOARD

### CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional patent application No. 62/044,869, filed Sep. 2, 2014, which is incorporated by reference.

### BACKGROUND

Electronic devices often include one or more connector receptacles through which they may provide and receive power and data. This power and data may be conveyed over cables that may include wire conductors, fiber optic cables, or some combination of these or other conductors. Cable assemblies may include a connector insert at each end of a cable. The connector inserts may be inserted into receptacles in the communicating electronic devices.

These receptacles may be a relatively large electrical component having a housing, shielding, contacts, and other structures. These receptacles may have an opening aligned with an opening in an electronic device. These receptacles may be mounted on a printed circuit board such as a main logic or motherboard.

Accordingly, conventional connector receptacles may be a component that is manufactured as a separate device, then placed on a printed circuit board and aligned with an opening in an electronic device. Electrical paths for power and data may be formed by conductors in a cable, pins in a connector insert at an end of the cable, pins in a connector receptacle, and traces on a printed circuit board.

But these connector receptacles may be relatively large. This may be undesirable since electronic devices are becoming ever smaller over time. Using a large receptacle may limit how small a device may be made, it may limit the functionality that may be included in the device, or it may limit both how small a device may be made and the functionality that may be included in the device.

Moreover, many smaller devices may not include a printed circuit board due to size constraints. These devices may instead include conductive pathways formed of flexible circuit boards or similar structures.

Thus, what is needed are connector receptacles that may be space efficient and provide direct connection to flexible circuit boards.

### SUMMARY

Accordingly, embodiments of the present invention may provide connector receptacles that may be space efficient and provide direct connections to flexible circuit boards. An illustrative embodiment of the present invention may provide an electronic device having a receptacle formed in a housing of the electronic device. The receptacle may include a recess in the housing. The recess may include a sidewall and a bottom surface portion. The bottom surface portion may include one or more openings extending through the bottom surface portion from an external surface to an internal surface. One or more contacts may be aligned with the one or more openings in the bottom surface portion. For example, the receptacle may include a plurality of contacts each aligned with one of the openings in the bottom surface portion. In various embodiments of the present invention, the contacts may be formed on a flexible circuit board. In

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this way, the receptacle may be space efficient and provide a direct connection to a flexible circuit board inside an electronic device.

Embodiments of the present invention may provide for a high level of resistance to water leakage. One embodiment of the present invention may include a seal located between an internal surface of the bottom surface portion and the flexible circuit board. This seal may be an insulative layer. This seal may be a flexible layer or gasket and may be formed of silicone or other material. This seal may also be formed of an O-ring or similar structure. The seal may have one or more openings to allow access through the bottom surface portion to the one or more contacts. The seal formed using this flexible layer may be a dust seal, light seal, particle seal, air seal, water seal, or other type of seal or combination thereof.

Various embodiments of the present invention may provide mechanical support for the flexible circuit board in various ways. In one embodiment of the present invention, a bracket may be used to secure a flexible circuit board in place such that contacts on the flexible circuit board remain aligned with the one or more openings in the bottom surface portion. The bracket may be fixed to the bottom surface portion, another portion or portions of the housing, or other structure attached or associated with the housing. The bracket may be fixed in place using one or more fasteners or other components. For example, one or more screws may pass through openings in the bracket into holes in an internal surface of the bottom surface portion of the housing. One or more alignment pins may be formed on the bracket and may fit in corresponding holes in the internal surface of the bottom surface portion of the housing, another portion or portions of the housing, or other structure attached or associated with the housing. The bracket may be attached to the flexible circuit board with a layer of adhesive, such as a pressure sensitive adhesive (PSA), double sided tape, or other adhesive.

Contacts may be formed on flexible circuit boards in various ways. In one embodiment of the present invention a flexible circuit board may include a flexible material supporting a first conductive layer. A portion of the first conductive layer may be exposed and not covered by the flexible supporting material. A second conductive layer may be over and attached to the first conductive layer. A plating layer may be over the second conductive layer. A coverlay may be formed over a portion of the flexible supporting material and around the first portion of the first conductive layer. The coverlay may be covered by an adhesive layer. A liquid photoimageable layer may be formed over the adhesive layer. The first conductive layer and the second conductive layer may be attached using a solder layer. The first conductive layer may copper, the second conductive layer may be stainless steel, and the plating layer may be gold. Additional plating layers of nickel or other material may be used as well.

In various embodiments of the present invention, these receptacles may be used often and may therefore remain accessible to a user. In other embodiments, these receptacles may be used less frequently. For example, they may be used during software or firmware updates and not used at other times. In these embodiments, a semi-permanent or removable cosmetic caps or cover seal may be placed over the receptacle opening to reduce water leakage and to otherwise protect the flexible circuit board contacts. In still other embodiments of the present invention, this connector receptacle may be accessible during manufacturing, for example, only during initial testing or programming. In these various